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Education and Training for Surveying and Mapping After the War*

O. S. ZELNER†

EDITOR'S NOTE:—Other papers presented at the Fourth Annual Meeting will be published in later issues of SURVEYING AND MAPPING.

IN ACCEPTING the invitation to collaborate with Professor Rayner in a discussion of "Education and Training for Surveying and Mapping After the War," I was motivated by two reasons. First, the question had been up for discussion in the Surveying Department at the University of Minnesota for some time, and second, I was particularly glad for the opportunity of working with Professor Rayner.

As to my portion of the discussion, it will soon be apparent that I have simply constituted myself a clearing house for the ideas and opinions of many teachers of surveying and practicing engineers. Instead of putting forward my own views as the suggested "needs and trends" for the entire Country, I decided to put a large portion of the responsibility on some of my professional friends.

To that end I prepared a short Questionnaire, which was divided into two parts, the first based on the list published in the April 1944 Proceedings (Yearbook Number) of the American Society of Civil Engineers. This was called "General Branches." The second was tabulated from my own ideas and from those of several faculty men and practicing engineers. This was called "Special Branches."

The Questionnaire requested the following information and opinions:

1. In your opinion, will particular emphasis be given to the following branches of surveying to such extent that extra attention should be placed on special training in these fields?

(General and Special Branches listed.)

2. In your opinion, where have engineering schools been remiss with respect to any of these branches? Will you add any suggestions you care to make?

ANALYSIS OF POLL

A most gratifying feature of the poll was the wide interest shown. Out of 54 copies of the Questionnaire sent, there were 50 returns, 46 of which were accompanied by clarifying letters. To indicate the value of

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* Condensed from paper presented at Annual Meeting, Washington, D. C., June 3, 1944.

† Associate Professor of Surveying, University of Minnesota.

the combined opinions, it should be noted that replies were received from 25 teachers, most of whom have had much experience in the field of surveying; and from 25 practicing engineers in the federal, state, and municipal services, and in private practice—all with wide experience in surveying and with sound judgment as to surveying needs.

There were practically no negative votes on any subject. The percentages given below are based on the number of "yes" votes with respect to the total number of questionnaires returned.

An analysis of the replies shows the following groupings of opinions:

General Branches

AERIAL SURVEYING. 80 percent answered yes; vote distributed evenly among teachers and professional engineers; several suggested an *appreciation* course only, for the majority of schools.

BOUNDARIES. 50 percent answered yes, with many emphasizing legal aspects.

CADASTRAL. 20 percent answered yes. Several consider this branch a future part of the coordinate systems.

CITY SURVEYS. 48 percent voted yes.

CONTROL SURVEYS. 52 percent voted yes; qualification by many that teaching be limited to second- and third-order work, leaving first-order work to be learned on the job.

COORDINATES (State Wide). 62 percent voted yes.

HYDROGRAPHIC SURVEYING. 26 percent voted yes.

MINE SURVEYING (Underground). A light vote—10 percent in all. Reason for affirmative vote based on fact that, because of manpower shortage, surveying and mapping has not kept pace with mine production which has gone forward under high pressure.

ROUTE SURVEYS. 34 percent voted yes. Several believed there will be a great upsurge in improved highways and railroads.

TOPOGRAPHY. 78 percent voted yes. Considered by many as strongly fundamental in training for surveying, because of elements embraced and because the resultant maps become the basis of design of practically all forms of engineering projects.

Special Branches

AIRPORTS. 56 percent voted yes. Strong support from city engineers, city planners, highway and railroad engineers.

BRIDGES (Long). A light vote—10 percent in all. Suggested an *appreciation* course as sufficient.

FLOOD CONTROL. 56 percent answered yes. Highway, railroad, and city planning engineers most interested in this branch of training.

GRADE SEPARATION. 48 percent voted yes. Supported unanimously by highway and railroad engineers and city planners.

IRRIGATION (Drainage added). Light support—13 percent in all. Majority felt it was too regional to deserve much attention in general.

HIGH-SPEED HIGHWAYS. 40 percent voted yes.

HIGH-SPEED RAILWAYS. 30 percent voted yes. Unanimous support from railroad engineers, city planners, and teachers of Railroads. One return from a teacher cited a case where a reduction of a curve from 45 min. to 30 min., plus streamlining, raised the speed from 80 to 120 m.p.h.

POWER DEVELOPMENT. 14 percent voted for some instruction in surveys and maps necessary in this branch.

TUNNEL SURVEYS. A light vote—8 percent in all. Majority felt that an *appreciation* lecture was sufficient.

WATER SUPPLY. 20 percent voted yes.

Extracts From Accompanying Letters

Following are extracts from some of the letters accompanying the Questionnaire. In many cases these letters are more valuable as a guide to needs in teaching, than is the accumulated weight of the replies to the Questionnaire. In every instance, permission to use the name of the writer has been granted.

MR. W. M. BEADIE, Assistant Commissioner, Minnesota Department of Aeronautics:

"Applying aerial photography techniques to the airport location problem would save a great deal of time and money as you would have a picture of the drainage problems, surface transportation, obstructions, and expansion possibilities. When the time comes to actually design the port, I cannot see how the usual methods of surveying can be revised."

PROFESSOR HARRY BOUCHARD, University of Michigan:

"I think that we have been remiss in land surveying and in not giving sufficient instruction in the use of state-wide coordinates. The only land surveyors I know have obtained their real training under someone engaged in that work. In the time available it seems impossible to specialize very much."

PROFESSOR EARL CHURCH, Syracuse University:

"I believe that the tendency during the past 20 years to place Surveying in the background in Civil Engineering courses has definitely proven to be a great mistake. In the future this situation should be rectified by offering in the Civil Engineering courses strong surveying "options."

REAR ADMIRAL L. O. COLBERT, Director, U. S. Coast and Geodetic Survey:

"It is the opinion of this Office that there will be a great expansion of all branches of surveying necessary to the prosecution of national mapping immediately following the war. Our experience during recent years indicates that there will be a general trend toward more accurate work, and therefore, the use of better instruments. I think some schools have been backward in the use of improved types of theodolites, levels, etc."

PROFESSOR EMERITUS E. F. CODDINGTON, Ohio State University:

"We feel that too much attention is given to the technique and routine of doing ordinary surveys and not enough attention to the fundamentals underlying the operations."

MR. H. M. DIBERT, W. & L. E. Gurley Co.:

"I am strong for boosting the effectiveness of teaching basic surveying for all schools and possibly somewhat restrict to appreciation courses only such subjects as Geodesy, Monumented Control, Coordinates, Photogrammetry, etc. I think the idea is slowly growing that those who wish to specialize in the higher branches of surveying might better go to selected schools where the personnel is experienced and the more expensive instrumental equipment for such teaching is available."

PROFESSOR G. BROOKS EARNEST, Case School of Applied Science:

"I firmly believe that present impetus to aerial photography will continue in the form of aerial mapping following the war. However, many engineering schools are not financially able to capably give particular emphasis to Photogrammetry. Therefore, a few colleges, well distributed, should establish comprehensive courses in this subject. Surveying has been minimized. Heads of departments of Civil Engineering have cut to the bone the time allotment to the subject of Surveying."

LIEUT. COLONEL HIBBERT H. HILL, U. S. Corps of Engineers:

"I have, for a long time, felt that serious consideration should be given to the amount of time devoted to Surveying, in its various aspects. It seems to me that this problem becomes more pressing as time goes on. In view of the increasing ground which civil engineers ought to cover in their college courses, it has seemed to me that we have turned out men quite well equipped as surveyors, but not equipped in the same degree as civil engineers. The amount of time devoted to surveying might be advantageously reduced by limiting the instruction to the same sort of fundamentals that are covered in, let us say, the course in Structures. This would anticipate that the individual would learn technique on the job after graduation."

PROFESSOR O. J. MARSHALL, Ohio State University:

"College courses should be designed to give basic knowledge which may be adapted after graduation to special applications. Time does not permit adequate training in special applications while in college. All phases of geodetic surveying and topographic mapping of large areas will need more emphasis. Possibly demand will not warrant all engineering colleges going into this advanced and specialized work."

MR. ADOLPH F. MEYER, consulting hydraulic engineer and author of "Hydrology":

"I find it difficult to say whether particular emphasis should be given to any one branch of surveying. It seems to me the field of engineering is so large that no student can receive much specialized training during the four-year course. If the fundamentals of surveying, with particular emphasis on topographic surveys and minor attention devoted to the other branches of surveying, are thoroughly taught the engineer will have to get his own education after he begins to specialize. It seems to me you could just about use all of the last two years of an engineer's time if you are going to make him really proficient in the twenty kinds of surveying outlined."

MR. SHERMAN MOORE, Head Engineer, U. S. Lake Survey:

"I see no reason for supposing that the "Period after the War" will be materially different from that preceding the war so far as mapping is concerned. Emphasis should be placed on fundamentals. The student should be given a thorough knowledge of the tools with which he will work. Most of the methods taught are not those used in actual practice, and each organization has its own methods of doing work."

MR. MURRAY Y. POLING, Senior Geodetic Engineer, U. S. Coast and Geodetic Survey:

"Schools have been "remiss" in their attitude toward the field of Surveying—even in 1944 some colleges tell their students that Surveying is not a profession, which puts it into the class of 'trades'. Teaching in general has not kept pace with private and public practice."

PROFESSOR PAUL P. RICE, Lafayette College:

"I have always had a feeling in this connection, which has only been intensified because of the war, that engineering schools generally have made a mistake in placing so much emphasis upon Structures and associated subjects. Somehow or other the student gets the idea in college that he doesn't amount to anything in Civil Engineering unless he designs or builds a bridge or some other monumental edifice, Surveying being, so to speak, the 'ash can' of Civil Engineering."

PROFESSOR H. O. SHARP, Rensselaer Polytechnic Institute:

"I think that we must admit that Advanced Surveying and Geodesy do not offer employment to a large number of engineers and it may be a mistake for a young engineer to specialize in this work, expecting to make it his life work. On the other hand, subjects such as these have a decided advantage for training purposes and for use in many engineering fields. I do not believe that schools should attempt to train specialists during four years of undergraduate training. A general course of study will be of greater advantage to a young man.

"Professors who are looking for time in their particular field, say there is too much time devoted to Surveying. Well, if it is squinting through a transit and measuring a few distances, yes, but it goes far beyond this simple task—in fact, it approaches a general Civil Engineering character."

MR. GEORGE M. SHEPARD, City Engineer, St. Paul, Minnesota:

"It is my opinion that Surveying and Mapping is basically one of the most essential elements in the training of the young civil engineer. Surveying teaches accuracy in physical measurement, and Mapping, of course, trains the student in the accurate portrayal of the results of surveys. Certain branches of surveying which are of a highly technical nature, would I believe be followed only by engineers who would specialize later and too much time should probably not be devoted to these special branches in the average Civil Engineering course.

"The Special Branches to which you refer seem to me to be variations of basic Surveying and Mapping which might be taken as examples during these courses, but I doubt the advisability of creating separate courses for these items. An engineer with basic training would soon adapt himself to the specialized requirements in these specialized types of work."

PROFESSOR DOUGLAS S. TROWBRIDGE, New York University:

"In my opinion the greatest difficulty is in finding space in an already crowded curriculum, and in selling to the Civil Engineering Department of each school the idea that Surveying is a profession and not a vocation."

MR. C. S. WEATHERILL, Chief Engineer, Minneapolis and St. Louis Railway: "Thinking along lines in which I am vitally interested, that being the future of railroads in this era of high speed, I think it would be well to give more study to Flood Control, Grade Separation, High Speed Railways, and Water Supply."

MR. WALTER WHEELER, Designing and Consulting Engineer: "To locate a bridge and the connecting highways or railroads it is necessary to have a fairly complete map of the territory to be considered, including topography, soundings, soil studies, geology, etc. Included in all of this, is necessarily a study of the stream to be bridged, its watershed, high-water marks, and estimate of probable extreme high water. This detailed study will determine which location is the best, and the one selected will be carefully and accurately surveyed, center-lines established, piers located and soundings taken on the site of the piers and abutments, ravine sections taken, approach roads surveyed, grades established, cross sections taken at regular intervals, and the whole situation nailed down tightly so that all the necessary information can be shown on the construction drawings on which the bidders will base their tenders."

Conclusions

From the summary of the Questionnaire it is apparent that there is a heavy weight of opinion favoring added stress on Aerial Surveying and on "old-fashioned" Topography. The next in order of emphasis are: Coordinates, Airports, Control Surveys, Boundaries, City Surveys, Grade Separation, High-Speed Highways, Flood Control, Route Surveys, and High-Speed Railways.

The letters reveal a strong belief in the value of fundamentals, several advocating the restriction of teaching to basic surveying problems with the young graduate learning the details of special branches after he is actually on the job. The feeling is also growing that, in highly specialized branches such as Photogrammetry, Geodesy, etc., certain schools with proper equipment and trained personnel should be prepared to accept such students as wish to continue in these fields. The opinion is strongly voiced by many that in the usual 4-year course in Civil Engineering there is no room for such specialization. That would presuppose that a student electing to follow any highly specialized course would go to the school of his choice as a graduate student.

Another phase of the teaching of surveying is that embracing subjects which may be of vital importance, but which have their techniques founded on basic surveying practice. Among these could be mentioned Hydrographic Surveying, Airports, Grade Separation, and Power Development.

It is my belief that such subjects should not be ignored or passed off as something so rare that they need no mention. As an illustration of what can be easily done along this line—in the 1941 Summer Surveying Camp of New York University, we were able to give a brief lecture on current meters, rate a meter, and measure the Navesink River in 1 day. Airports surveying is another example of what is meant. Granted that any man

well grounded in basic surveying should be able to do whatever surveying and mapping is necessary for the design and construction of the ordinary airport, it is still urged that he should have what Mr. Dilbert aptly calls an *appreciation* course—he should know that there must be an adequate and accurate topographic survey with 1- or 2-foot contours so carefully drawn that from the map, runways can be located, grades can be established, drainage can be designed, and earthwork estimated.

As an example of what may happen when preliminary surveys and maps are not properly executed may be cited a recently projected airport of considerable importance in one of our Northwestern states, where the contours on a gently rolling farm often touched or crossed, many contours bumped into each other at right angles and stopped. In one spot five contours met in a point.

In the light of present developments, this question of Airports and the attending needs in surveying and mapping, must be given some thought. Assistant Secretary of Commerce, William A. M. Burden, stated at a recent meeting of the Institute of Aeronautical Sciences, "Of prime importance is the expansion of our airport system so that the private pilot can go where he wants to go; and further, the Civil Aeronautics Administration's national plan, which will probably be completed in the next 2 months, will call for a total of practically 6,000 airports, or twice the number we now have."

Representative Jennings Randolph of West Virginia recently stated, "There now is pending in Congress a resolution to provide for a nationwide airport survey as a guide to a vast postwar construction program designed to provide 20,000 landing fields and flight strips throughout the country."

In my opinion this means not only some emphasis on at least an appreciation course in Airport surveys and maps, but also the employment of many engineers, which may be of vital importance in the after-the-war period.

Surveying and Mapping for Water Power Developments also merit appreciation lectures. Too many civil engineers think that all that is needed is to run out the flowage line to see if the water will escape when the reservoir is filled. Many are not aware of the Federal Water Power Commission and its rules.

It is not necessary to indicate to this group the position Surveying and Mapping have in the overall engineering picture, but a portion of a paper by Professor Philip Kissam of Princeton University, published in the October, 1943 Bulletin of the American Congress on Surveying and Mapping so clearly outlines this truth that I feel that even though you have read the paper it is so pertinent to this discussion that it should be repeated here. Professor Kissam says in part:

When a study is made of the courses dealing with Surveying and Mapping, it must be borne in mind that these courses must not only train the student in how to survey and how to make a map, but in many other engineering requisites as well. For example, every successful civil engineer must handle men. The survey field parties give him this opportunity. An engineer must learn to check his work. The mathematical checks in surveying courses provide this training. He must learn the danger and ease of making mistakes. A few survey closures will demonstrate this to him. He must understand how to measure things, the effect of repeated measurements, and how to handle accidental errors. These are taught in Surveying. Surveying along with engineering drawing are usually the first professional courses which the student engineer receives. The course in surveying is relied upon to give him the principles of the engineering approach. He learns the necessity of reconnaissance or a general view of the problem, the importance of the preliminary survey or the collection of important data, the arrangement of the data in a workable form or a map, the development of the plan utilizing these data, and the execution of the plan illustrated by the location survey.

In closing I wish to emphasize this fact as evidenced by returns in the Questionnaire and in the letters:—No radical change has been indicated either in course content or teaching procedure. However, many of us teachers should be led to ease up in some directions and put on more pressure in others.

We may glean considerable comfort from President Wickenden's statement in which he assures us that "The war has revealed few deficiencies in pre-war engineering education."

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Education in Surveying and Mapping After the War*

WILLIAM H. RAYNER†

THE ACHIEVEMENTS of science and engineering in recent years and months have induced an attitude of hopeful expectancy for all kinds of miracles in our world when this war is over. And so even in the cloisters of learning there is a slight stir about engineering education after the war. Since surveying and mapping form a part of the curriculum of practically all of our engineering schools, any discussion of our subject must necessarily refer both to engineering education in general and to surveying and mapping in particular.

* Presented at Annual Meeting, Washington, D. C., June 3, 1944.

† Associate Professor of Civil Engineering, University of Illinois, and Vice President, Region 4.

The subject may be discussed under four headings; namely, the conditions, the aims, the methods, and the content.

The Conditions

For a period of at least 2 or 3 years after the war, engineering education will be affected by a number of adverse conditions. There will be a considerably increased enrollment of men. This increase will impose serious problems as to classroom space, laboratory facilities, size of sections, and qualified teachers. Many of these men will be accustomed to action and excitement and will be more mature than the regular students, making it more difficult for them to assume the routine of study. Their qualifications will differ greatly as to ability, preparation, and purpose. Accordingly, it will be difficult, if not impossible, to maintain the customary standards of achievement. Or, if past standards are maintained, a greatly increased mortality in enrollment is sure to result, with the accompanying sense of failure on the part of these men.

Because of these conditions, some educators think the number of men who will attempt to complete the 4-year courses will be relatively small; but that there will be a large demand for instruction in subprofessional, technical, and vocational subjects extending over perhaps a 2-year period. It is also expected that many of these men will prefer to pursue their studies in the various cities in extension courses, where they can have regular employment and take the added instruction in part-time or evening classes. To avoid the crowded conditions in the colleges and for the satisfaction of the students, it is hoped the latter expectation will prove to be correct.

Any feeling of inferior status by these men may be relieved if they are informed that a recent investigation shows that the "earning power of a group of one thousand 2-year technical graduates is within 5 percent of the earning of a large group of 4-year college graduates, and the demand for this class of employee is about three times as great as for men with a college degree."

Aims

The general aim, of course, will be to adapt the subject matter and to change the emphasis of instruction in surveying and mapping to conform to the new conditions which our changing world has brought about. At least three changes may be mentioned: First, a greater emphasis to be laid on the accuracy of and the specifications for all surveys and maps. Not that all are to be executed with the utmost accuracy, but that a better understanding of what precision is required for a given survey or map and how best to obtain it will be required of the surveyor of the future. Second, a more adequate treatment of the subject of Land Surveying; and

third, a new emphasis on the much-discussed humanistic element in engineering education.

We may now discuss, briefly, the means both as to methods and subject matter by which these aims are to be achieved.

Methods

It is not likely that the new conditions will require many changes in the present methods of instruction which have proved to be effective. However, any considerable increase in the size of classes will require a greater use of the lecture method instead of recitation and laboratory methods. A possible aid in this situation will be the use of visual aids by demonstrations and motion pictures, which are now so widely used by the armed forces.

The requirements of increased accuracy in surveys, the demand for higher qualifications for land surveys, the rapid developments in photogrammetry and other phases of surveying, indicate that the whole field of surveying and mapping is being raised to a higher plane of performance; and, accordingly, there is a corresponding responsibility on our engineering schools to provide additional preparation either in the upper classes, or in the graduate schools, to provide for those who wish to qualify adequately for future surveying practice.

In 1937 a national conference of teachers of surveying was held at Camp Marston, the summer camp of the Department of Civil Engineering of Iowa State College, on Rainy Lake in Minnesota. The prime mover in this conference was Professor John S. Dodds, a past President of this Congress. This conference had such a notable effect on all who attended that regional conferences followed in rapid succession: at Rensselear Polytechnic Institute, March 1938; at the University of Louisville, September 1938; at the Missouri School of Mines, April 1939; at Georgia School of Technology, September 1939; and a Second National Conference at the Case School of Applied Science Summer Camp, in August 1940.

These were all sponsored by Committee 8 on Surveying and Geodesy of the Society for the Promotion of Engineering Education and proved to have a notable effect in improving the methods and subject matter of surveying instruction. A sure prediction for the postwar years is that these conferences will be resumed to the great pleasure and benefit of all concerned.

A number of our states had also begun to hold annual state-wide conferences, dealing with the special conditions within each region. These included Iowa, New Jersey, Illinois, and Missouri. These conferences, it is hoped, will spread to other states and continue with renewed vigor after the war.

The Content

The new aims will modify principally the content of the courses of instruction.

As regards the greater emphasis on the humanistic element in engineering education, this subject is of long-standing and perennial interest. It well merits Mark Twain's famous remark about the weather, "Everyone talks about it but no one does anything." However, the evident imperative need for mankind to deal with human relations with greater understanding and success will, I think, bring a new significance to this phase of engineering education.

In a recent study of the aims and scope of engineering curricula by a distinguished committee, they recommend a group of humanistic-social studies to be given in parallel with technical subjects. They include philosophy, economics, and government in sufficient amount to make every engineering graduate aware of and somewhat intelligent about the human relations of the world in which he must live. Room for these subjects is to be made principally by a reduction in specialization of technical subjects.

The increasing use of precise control for large-scale engineering projects and for city surveys is having a notable effect on the teaching of advanced surveying. Also, the use of State Plane Coordinate Systems requires traverse and triangulation of at least third-order accuracy, if the stations located are to be assigned permanent coordinates. Accordingly, it would seem that in the future a minimum requirement for instruction in surveying for all civil engineering students would be a thorough treatment of the field and office procedures for third-order accuracy for triangulation, traverse, and leveling.

We are still the legatees of the crude and hurry-up methods of the early land surveyors and of the railroad and highway surveys, where speed has always been the all-important consideration. But this condition is slowly changing. The greater emphasis on accuracy will require more attention to the theory of errors, the adjustment of the errors of observation, and the behavior of errors in the field measurements, to the end that more definite specifications will be drawn to govern all field operations to insure the requisite accuracy with the least expenditure of time and effort. An inspection of the literature of engineering surveys shows a woeful lack in the past, of any use of analytical specifications for either the instruments, the field measurements, or the mapping.

The rapidly developing methods of photogrammetry are of such importance and practical use that some understanding of this subject is required of every civil engineer. This condition has already been recognized by the introduction of elective courses and the modification of required courses of instruction. Inasmuch as photogrammetry has already supplanted to a wide extent, the planetable in hilly terrain, it is probable that

instruction in photogrammetry will be assigned some of the time formerly devoted to the planetable.

Surely, of all the various kinds of surveying in these United States that of land surveying is the sorriest. Within the last month a practising surveyor, in assuming membership in the Congress, wrote a letter to President Whitmore in which he made this statement, "I do not know how all of the other states are, but in my own state and in some of the others that I personally know about, the average county surveyor is a joke."

Slow progress, I think, is being made to improve this condition. Massachusetts, with its excellent system of control and its land court, with all surveys under competent supervision, is our shining example of how land surveying should be done. Some rather extensive WPA projects in recovering land corners have been conducted under excellent supervision, and the license laws in the various states are being improved. These conditions are laying an increased responsibility upon the engineering schools to provide more adequate instruction in this subject. And so there are some grounds for the belief that this important branch of surveying is actually moving forward.

Those of us who were present at the first meeting of the Congress in 1941 may remember that one of the resolutions passed at that meeting called upon the educational institutions to accord the subjects of surveying and mapping greater recognition as a major branch of engineering. The developments of which I have spoken and which will surely characterize education in surveying and mapping in the postwar period are such as to merit and command the recognition, which the significance and importance of these subjects warrant.

DISCUSSION

THE CHAIRMAN (Rear Admiral Colbert).—Let us discuss at this time the first two papers.

MR. A. L. SHALOWITZ.—It appears to me, Mr. Chairman, that the first two papers have been oriented around the question of fitting surveying and mapping into the regular undergraduate course in civil engineering, without considering the advisability of establishing in the colleges a complete course in surveying and mapping which would lead to a degree. If we are to fit it into the standard civil engineering course, then it stands to reason that no major changes can be effected except at the expense of other equally important subjects—which would be undesirable. But need we do this? I think not.

It is my belief that surveying and mapping has reached a stage where it

can stand on its own footing and should be comparable to other complete courses. In this connection it may be of interest to you to hear a little of an article that appeared in a recent issue of the Empire Survey Review entitled, "Training African Surveyors in Nigeria."* In their course 4 years are devoted to the training of surveyors. The first 2 years consist generally of the preliminary subjects, like advanced mathematics, physics, and so on. The following 2 years are devoted entirely to the theory and practice of surveying and mapping. After this the student must pass a government qualification examination before he is allowed to practice surveying.

It seems to me our English cousins have taken the correct view of the matter. Why should we burden the student with subjects such as thermodynamics, sewerage, and so on, if he is to become a surveyor? It is of course not advocated at this time that all colleges include a complete course in surveying and mapping in their curricula. But it would be a step forward if a few colleges well distributed geographically could be persuaded to institute such courses, much the same as is now done in other fields.

If this Congress is concerned with raising the standard of our profession, then it appears to me, here is an approach. Fundamentally, the status of a profession is determined by the amount of education and training required to practice it. It will not be determined merely by setting standards of accuracy for given types of surveys, although the latter are important to establish at this time.

THE CHAIRMAN.—Prof. Zelner, would you care to comment?

PROF. ZELNER.—I do not believe I know enough about the article to say anything worthwhile. I wish we might hear more. The first 2 years are more or less comparable with what we do in our first 2 years, and so far as the second 2 years being devoted entirely to surveying and mapping, leading to a degree, there are two or three letters that came to me that suggested that same thing, so the idea is beginning to spread.

PROF. RAYNER.—Is there any one here from the University of Michigan who took the surveying and mapping instruction at that university? That is the only university I know of which did attempt to establish a complete curriculum in surveying and mapping. I understand, however, that it took the enthusiasm of Prof. Johnson of that institution to carry it along and, if I am not mistaken, that entire curriculum has been abandoned at the present time. I think that we will have to wait until we have abandoned or have been able to change from this apathy to surveying and mapping which I spoke of and that we will eventually acquire the attitude which is prevalent abroad as indicated in this paper. We know of course that in

* Reprinted in SURVEYING AND MAPPING, July 1944.

Europe they have an entirely different attitude toward this field, and that as we acquire maturity in our own advancement, we will demand a modern degree of instruction in this field in our universities.

PROF. CODDINGTON.—I am considerably interested in the two different points of view. Prof. Rayner has just said that the apathy which exists makes it impossible to do very much about improving training in surveying beyond a certain state or beyond the amount they are trying to do. I don't exactly agree. I should say that the other, the utilitarian view, is that you might go to the extent of teaching students the whole story of precise surveying and mapping so that there is nothing left to be done. I think we could do something more than is now being done. Most institutions do not pay enough attention to surveying.

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AUTOMATIC MAPMAKER DEMONSTRATED

"An 'odograph' that makes its own map was recently demonstrated by the Army Engineers at Fort Belvoir, Va.

"The land odograph automatically plots the course of a moving vehicle on a map of any desired scale through the co-ordination of a magnetic compass and a speedometer for recording the distance traveled. For instance, a jeep traveling at night over unknown country can explore far and wide and return to the starting point with a map accurate down to one or two per cent.

"If a map already is available, it can be placed in the recorder, which is then adjusted to scale. A pencil placed on the starting point will indicate the position of the vehicle anywhere within the limits of the map. In such circumstances, any soldier who can read would know where he was at all times, the engineers say.

"The instrument was developed by the Engineer Board in cooperation with National Defense Research Committee, the Department of Terrestrial Magnetism of the Carnegie Institute of Washington, and manufacturers of calculating machines. . . .

"At the demonstration a jeep equipped with the odograph accompanied the inspection party for miles over this training base and returned to the starting point with a complete record of the route followed."

—W. H. Shippen, Jr. in the Washington *Evening Star* August 30, 1944.

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"Maps can save the mind an infinitude of words."

—SIR H. G. FORDHAM.

Surveying Needs a Lift

The following letter was received by President Whitmore from a recently enrolled member. Because of its significance to the surveying profession in general and the Congress in particular, it is being reprinted here with the author's permission.—EDITOR.

YOUR LETTER regarding the American Congress on Surveying and Mapping received, and I am very glad to have a chance to find out what I want to know. I joined the Congress because I am trying to find something that will really help to get the profession of surveying out of the condition that it is in now—and has been in ever since I have been in "the game." The real wealth of the State of Georgia is in its real estate, which statement might apply to almost all of the other states of the Union. In Georgia and some of the other states that I personally know about, the average county surveyor is a "joke." I know this, because I was one for 20 years. Now that is the type of man who has to do with the property titles, measurements, boundaries, and other things pertaining to the surveying, mapping, and calculating of real estate—the biggest taxable asset in the entire state.

I have spent the greater part of my 29 years of engineering on area surveys, and I was not in "the game" very long before I was disillusioned. I had always thought that a great part of surveying was done reasonably close to what it should be. I found, however, that only a very small part of it is done with any degree of accuracy, and that, of all things, there are agencies that have some of the most incompetent men—not only on their survey parties, but actually in charge of the surveys and mapping. One surveyor looks just like another to them, and it is just plain luck for a survey to close when the calculations are made.

It has taken me a long time to get as far as I am now. I am not as far as I might be perhaps; but on area work for records and on such work as farm surveys, ownership maps, and contour maps for extensive grading, I know that there are few around here who do as well as I. I spent a lot of time and money as one of the committee that sponsored the law governing surveys in Georgia. A Board was appointed and, ever since it has been functioning, there has never been a man on it who knew any more than to think that the average survey is as good as it should be. No improvement for surveys has been made yet in Georgia.

I have been trying to get a change in the law governing fees for surveys in Georgia, but so far have been unsuccessful. This law was passed in 1792. Several years ago I surveyed a big farm. My bill amounted to $195.75, which the lawyer who had hired me refused to pay. He took the case to court and cited this law and its provisions—and I wound up with $11.50. And I am not a county surveyor any more either!

I want to know more about *our* organization. I would like to get all that there is in it, and even then I'll be needing a whole lot more to balance me up with the others. I just don't know as much as I want to know, and the only way I can come close to keeping up is to work hard and keep on trying.

I have a lot of capable men whom I have developed into real good surveyors. I don't know enough about the "Congress" yet to recommend it to them, and I want you to tell me just how it will help the average surveyor to do a better job. If it is not going to help that man, then I want to know whom it *is* going to help. I sometimes have as many as 10 to 20 parties, and I will do anything I can to get them into any organization that will help them—for then it will be helping me in no uncertain terms. I might not be the type of man that you need in your organization. I am afraid that I am not the type of man that some of the other organizations need, even though I have been accepted. I know that it is my short coming if I do not help to run any society of which I may become a member. If I feel I know a better way to do anything, then it is up to me to demonstrate my "wares."

JOHN F. CAREY,
Contracting Engineer.

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CIVIL-DIVISIONS BASE MAP OF THE AMERICAS

THE AMERICAN GEOGRAPHICAL SOCIETY announces the publication of a base map of the administrative divisions of Latin America in three sheets on the scale 1:5,000,000. This map, which corresponds in layout to the Society's three-sheet Map of the Americas, has been prepared for use in the plotting of statistical data and other regional information for purposes of research, display, or reproduction. The compilation was undertaken as a project for the Division of Geography and Cartography of the Department of State, and the drafting and printing were sponsored by the Coordinator of Inter-American Affairs.

Grid, coastal outlines, and major political divisions appear in black, minor divisions and reference numbers in nonphotographic blue. Thus, although secondary boundaries and reference numbers are available for the plotting of statistical material, they are eliminated when regional or statistical drawings are reproduced by photographic processes.

An accompanying pamphlet lists the approximately 5,000 civil-division names both numerically and alphabetically, affording an easy reference from base to statistical source or vice versa. A brief list of the maps con-

sulted (in addition to the 107 sheets of the Society's Map of Hispanic America, 1:1,000,000) is included in the foreward to the index, and a supplementary list of the new Brazilian *municipio* name changes declared in effect from January 1, 1944, to December 31, 1948, and newly created municipios not indicated on the map is given at the end.

The Society will welcome any information on corrections and additions to the base that may come to the attention of its users.—*Geographical Review,* July 1944.

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SURVEYORS USE WALKIE-TALKIE

AT A CONFERENCE held in Denver, Colorado, the use of two-way radio for communication with field parties of Government surveyors, and the employment of a greater degree of air photography in the measurement of large tracts of the public lands were discussed by General Land Office experts in land identification, as possible postwar developments in scientific cadastral engineering.

Feasibility of the two-way radio for use in land-survey work was established in brief demonstrations at the Denver meeting, when contact was made from an inexpensive transmitting set with equally inexpensive mobile receivers.—*Inside Interior,* June 1944.

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SURGERY BY TRIANGULATION

THE LIFE OF A SOLDIER wounded by a bullet or shell fragment may depend on the speed with which the metal can be located and removed.

Today, in army field hospitals, *only one minute* is required to discover the fragment and locate it in two planes, incidentally giving the surgeon two points at which incision may be made and also the correct angles and depths beneath the skin.

This is made possible by the Westinghouse Bi-Plane Marker, a device which translates the conditions shown by the fluoroscope into "guide posts" for the surgeon's knife.

Used with the Bi-Plane Marker is the Re-orientating Device, which, makes certain that the position of the patient on the operating table is exactly the same as during the fluoroscopic examination.—Advertisement in *Scientific Monthly,* August 1944.

Federal Surveying and Mapping Agencies

This is another in the series of sketches of the history, purpose, and scope of activities of federal agencies engaged in surveying and mapping.—EDITOR.

U. S. HYDROGRAPHIC OFFICE

Navy Department

THE FULL STORY of the work of the Hydrographic Office during this war will have to wait until the veil of secrecy has been lifted. But in part, the story can be told by our fighting men all over the globe. The great convoys that carry them to foreign shores followed their tortuous courses planned out on Hydrographic Office charts. The landing barges took them to enemy beaches only after a thorough study of the charts and other data supplied by the Hydrographic Office. This data consists mainly of the character and extent of the beaches, the currents and tides expected, description of reefs, the weather, and many other factors necessary to the success of the landings. The great fleets came to anchor after battle in anchorages surveyed and guaranteed safe by Hydrographic survey ships that preceded them by only a few days.

All this would not have been possible had not the Hydrographic Office of the United States Navy been prepared with the necessary information to give a worldwide coverage of such a volume of hydrographic information. The plant at Washington, in order to meet the great expansion, increased in size proportionately. The survey ships have increased in number to five large ships and several smaller ones. Three of these ships have been equipped with lithographic plants in order that they may produce nautical charts at the site of the survey. All of them have been commended by their superiors at one time or another for the outstanding contributions they have made towards the victories in the Pacific Ocean.

HISTORICAL

The Hydrographic Office, from its inception as the Depot of Charts and Instruments in 1830, has always endeavored to fulfill its mission to the men who go down to the sea in ships. This mission is to collect, digest, and issue timely information to mariners and aviators, offering them the

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Prepared in the Hydrographic Office.

maximum possible navigational safety and facility over the sea routes of the world. To accomplish this, a tremendous amount of data has been received from those who travel the oceans in all corners of the earth. In addition to accumulating this vast amount of hydrographic data, much was done in the Office to increase the production of better charts and publications. The names of Wilkes for his explorations and Maury for his geographic investigations are well known to all who are interested in geography. The bathymetric developments of the North Pacific by the *Ramapo* and of the Continental Shelf of California by the *Hull* and *Corry* were noteworthy contributions to science. The original application of the offset lithographic process to chart production and the invention of the Pantograver by Hydrographic Office personnel did much to increase the production of nautical charts by all nations. The Hydrographic Office has always been well to the front in collecting and publishing useful material for the navigator and in constantly improving its charts and publications as more and better data are acquired.

The public, especially the mariners and aviators, know the Hydrographic Office through its charts, manuscripts, and other publications which can be grouped as follows:

Nautical and Aviation Charts
Special Purpose Charts
Sailing Directions, Light Lists and Naval Air Pilots
Notices to Mariners, Notices to Aviators, Daily Memoranda, Radio Broadcasts, etc.
Technical Manuals, Mathematical Tables, etc., for the use of navigators and engineers.

Surveys and Charts

The charts of the Hydrographic Office today cover the entire surface of the globe. The Mercator projection is used, as it has proven most acceptable to navigators in their various navigational problems. Nautical charts cover principally the water areas, and the aviation charts follow a definite system of scales. For the nautical chart, the general coastal charts throughout the globe are constructed on a uniform scale of 4½ inches to the degree of latitude on the Equator; special coastal charts on a scale of ¼-inch to the minute of latitude; and harbor charts on large scales varying from 1 to 10 inches to the nautical mile. A general series covering all of the oceanic world except the Polar Seas is constructed on a uniform scale of 6/10 of an inch to the degree of longitude on the Equator.

The aviation charts are constructed to give a world coverage on a scale of 1 inch to 30 nautical miles. Aviation charts cover strategic areas

of the world on a scale of 1 inch to 3 nautical miles; and other aviation charts cover special areas on a scale of 1:2,000,000. The above charts are all on the Mercator projection.

Hydrographic Office nautical charts are constructed from original surveys executed by the United States Navy or by recompilation from foreign charts and manuscripts. No nation can survey all parts of the world. Every nation has, however, felt at liberty to use the material on charts produced by other countries, providing due credit is given in the legends to the authority furnishing the information. The Hydrographic Office keeps a complete file of all charts of the various nations of the world and from them compiles charts for the use of American seamen and fliers as a supplement to the large number of charts made from original surveys of the U. S. Navy.

Those areas of the world which are not adequately charted and which are of interest to our Merchant Marine and Navy are surveyed by ships of the United States Navy under the technical direction of the Hydrographic Office, and in collaboration with the foreign government concerned. Hydrographic Office charts are published from these data. During peacetime, the Navy has survey expeditions working continuously in foreign lands compiling data for charts that are necessary for safe navigation. Most of this work in recent years has been in the Western Hemisphere but in the past surveys have been made in all corners of the earth from Georges Bank to China.

There are many charts other than the nautical and aviation charts issued by the Hydrographic Office. The oldest of these is the Pilot Chart based upon investigations originally started by Mathew Fontaine Maury early in the nineteenth century. Some of the other more important special purpose charts are as follows: The Upper Air Pilot Chart, an adaptation of the Surface Pilot Chart to the use of the Aviator; monthly Sea and Swell Charts; Radio Compass Ranging Charts for the globe; Tracking Charts showing ocean routes; Bathymetric Charts; Aerological Plotting Charts; and many others, all of which have world coverage on many scales.

Publications

The Sailing Directions, Naval Air Pilots, Light Lists, Radio Aids, and Aircraft Facility Directory are hand books designed to supplement the charts. There is much information of importance in relation to any area that cannot be depicted on the chart, and it is to provide this information that these publications are supplied. The information for these publications is secured from Naval surveys and translated from many foreign sources of data. In all, the Hydrographic Office publishes about one hundred different volumes of this type of material. In order that these publications may be kept up to date while in use, a supplement of each book

is issued annually free of charge to the holders of the books.

It is of primary importance that all charts and publications of the Hydrographic Office be as nearly up to date as practicable at all times with regard to changes and newly discovered information. This information is received from many sources and in all modern languages. When translated, examined, correlated, and published, this information is issued free—monthly, weekly, and daily—as a service to the users of our publications in order that they may have the latest corrections and additions. These services are rendered through the weekly Notice to Mariners and Notice to Aviators, Daily Broadcasts, and Weekly Hydrographic Bulletin.

The Hydrographic Office alone has the statutory obligation of producing manuals and epitomes of methods and mathematical tables required in the practice of navigation. Many research programs are carried on investigating new methods of navigation and new applications of old methods, and in the development of many manuals of navigation for the guidance of mariners in conducting their observations.

This Office has faithfully fulfilled its obligations to the maritime world for the past 114 years and today is better prepared than ever to continue this service. The fact that the Hydrographic Office is one of the greatest fact-finding and fact-publishing agencies in the world concentrating on the science of the sea makes this possible. The Hydrographic Office can well adopt the slogan, "We Chart the World for America."

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Maps a Major Wartime Industry

". . . . World War II has given the United States Army the greatest and most varied collection of maps in world history.

"Both original and revised maps pour by millions from the army's huge printing plant. So far it has turned out more than 69,600,000 copies of 3,132 different maps for General Eisenhower. During 1943 army cartographers made 8,746 original or manuscript maps—a map for about every hour in the year.

"But that is not the full story of army-map production. Behind all battle fronts there are small printing plants in automobile trailers, capable of turning out 5,000 photomaps an hour and of printing line maps in four colors, if that is desirable.

"Before and after the landing at Salerno high-speed map printing in

Sicily, and ultimately on the beachhead, kept officers abreast of the enemy's maneuvers and his alterations in the terrain. In less than a month, four men working at a trailer press printed 47,000 maps; and the landing at Salerno was spearheaded by maps. . . ."

—Frank Henry in *The Baltimore Sun*, June 4, 1944.

" . . . Fortunately, as our military forces reenter Philippine waters they will have available excellent charts, the results of surveys made by the Coast and Geodetic Survey continuously over a period of forty years. The surveys on which these charts are based show in detail the character and extent of the offlying coral reefs which too often, in areas improperly surveyed, have cost the lives of many American soldiers and marines. The detailed surveys of Philippine waters copied and stored in the United States before the Japanese occupation are proving to be a valuable asset in the preparation of the proper types of landing charts and related information needed by the amphibious forces. . . ."

—Comdr. Bowden in *Annual Report*, Division of Charts.

The Aeronautical Chart Service, Army Air Forces, and its cooperating agencies, printed 27,800,000 copies of aeronautical charts during the fiscal year 1944. Of these, 20,038,000 charts weighing approximately 1,336 tons were shipped out for use of the Army Air Forces for both operations and training in all parts of the world. In order that these charts may include accurate topographic details, a total of over five million square miles coverage of aerial photography was compiled during that time, and 1,527 astronomic positions were observed and verified.

In the Coast and Geodetic Survey alone, 20,000,000 nautical and aeronautical charts were produced during the past fiscal year for training purposes in the United States and for operational use in all combat areas.

—Editor.

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"A Geographic Labourer pitched his tent,
With books supplied and instruments of art,
To measure height and distance—lonely task."

—Alfred Tennyson.

Maps and a Mapping Program for the United States*

F. J. MARSCHNER†

MAPS constitute one of the principal depositories of knowledge pertaining to conditions on the earth's surface. Precision and extent of surveys, contents and functional adaptability of the maps to research and investigation reveal, therefore, how well a country is prepared to deal with the problems created by the dynamic forces of progress and change.

In an economic unit like the United States, with its great variations in geographic conditions and irregular distribution of natural and human resources, localized facts of the situation must be known to permit an orderly, progressive development and adjustment of the economic structure to its natural foundation and economic needs. Definite information is needed as to what our resources are, where they are, to what extent they are used, how they are used and can be used, and with what results. Although the store of factual information along these lines is accumulating, we are far from having uniform, reliable, and complete records. The reason back of these deficiencies is that much of the pertinent information cannot be gathered by enumeration or obtained from sample questionnaires. Such information must be secured through systematic mapping and is comprehensible only when expressed in the form of maps. This applies not only to industrial raw material, primary power, commercial development, transportation and communication facilities, but is particularly true of physical characteristics of land when agriculture and the use of land are concerned.

Surveying and mapping was started in the United States during Colonial days, and although maps played their part in the formative period of our national life, they were entirely inadequate in number, scale, content, and precision to provide our administrators and pioneer settlers with the guiding information as to the location, quality, and use possibilities of our natural resources. Many of our present land-use problems are the outcome.

Mapping in the United States has never caught up with the needs of the Country. Only about half of the Country has been surveyed topographically, and of this a large proportion represents work done more than 40 years ago by methods now obsolete and on scales inadequate for present needs. Moreover, the demand for accurate maps containing specific in-

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† Mr. Marschner is a cartographer and a member of the staff of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

formation for a wide range of purposes is increasing. Geographers and land economists who study local problems in relation to regional, national, and international conditions need maps which range from large-scale maps showing individual land ownership to small-scale maps which portray the Country and even the world as a unit.

Cadastral Surveys

Cadastral surveys that systematically define boundaries of land ownership with a consistent degree of accuracy are lacking for most of the United States. In the public-domain states and in parts of other states, where the land has been divided into rectangular tracts, it is usually a comparatively simple task to construct a diagrammatic land ownership map which will supply such information in acceptable terms for some purposes. The situation is much more difficult in the areas of "indiscriminate" settlement in the older states.

Land tracts in this part of the Country are irregular in shape, were sold or granted under different statutes and regulations, frequently without proper land surveys or identification. Overlapping grants were not uncommon. In 1839 the Surveyor General of Georgia furnished the legislature of that State a report on the status of land grants in the "Head Right Counties," which are located along the coast and extend inland between the Savannah and Oconee Rivers. "This report of the Surveyor General . . . shows that the 24 counties existing in 1796 contained actually 8,717,960 acres of land, whereas the maps and records in the Surveyor General's office show that in these counties there had been granted 29,097,866 acres."[1] In one of these counties a proper land survey has been started only recently.

Surveys of irregular tracts of land, made in bits and pieces by different men at different times on different scales with different degrees of accuracy, without proper monumentation in the field or coordination of record, cannot readily be fitted together to produce a coherent assembly of land ownership.

> There is one and only one remedy for this, and that is to connect all detached surveys with a general system of triangulation, and it will save the Government and the inhabitants generally a vast amount of money to establish this triangulation as quickly as possible.

Thus wrote Sir David Gill from Cape Town to the Rhodesian Government in 1897.[2]

As is evident from the above quotation, horizontal control is not a requisite peculiar to American conditions. Most of the older countries

[1] McLendon, S. G.: History of the Public Domain of Georgia, p. 57, Atlanta, Ga., 1924.

[2] Hinks, Arthur R.: Maps and Surveys, Third Edition, p. 211, Cambridge, 1933.

experience similar difficulties and have reached or will reach the same conclusion.

Great Britain was one of the first countries, if not the first, to extend the use of the triangulation control of the national survey to the whole country. It was first applied in the cadastral survey of Ireland in 1825. Land taxes and rates in Ireland were inequitably framed. To secure a foundation for proper land valuation a survey was needed. The initial controlled cadastral plans were prepared on the scale of 6 inches to the mile, but even this did not prove satisfactory so that later the scale 1:2,500, and, for cities, even larger scales were adopted. Finally the scale 1:2,500 emerged as the principal scale on which all the other maps of Britain are based.

In America, we have a long way to go to produce anything like the English National Plans in regard to uniform and systematic coverage. The larger engineering projects will find it necessary to tie-in their surveys of land ownership with the national triangulation system, but this produces only scattered areas identified by these projects. Legal and administrative difficulties seem, however, to provide the most convincing arguments for the inclusion of the cadastral surveys into the National Survey Control system. This was the case in England, where the unbalanced land taxes in Ireland made Ireland the proving ground to demonstrate the merits of the system to the rest of Great Britain. In the Western Hemisphere we have a similar case. Here it was not a state of the Union but the Hawaiian Islands, before they became United States territory, which called for disentanglement of their land ownership question, the aftermath of the change from a feudal regime to a constitutional monarchy. The Hawaiian Government Survey based on triangulation control provided the remedy. Now the Hawaiian Islands have one of the most efficient land administrations in the United States.

Meanwhile, the need of permanent boundary marking in the field and a more definite description of the boundaries in land titles based on accurate land surveys has become increasingly evident in the continental United States. The establishment of the state systems of plane coordinates by the U. S. Coast and Geodetic Survey as a part of the National Control System has gone far to achieve these objectives.

Boundary location and land ownership, aside from the technical side of demarcation, surveying, and mapping, also have their legal aspects and implications. In our government structure, cadastral surveys, aside from the Public Domain, fall within the realm of state functions, and the use of plane coordinate systems for legal descriptions in land titles requires enabling acts by the states. So far, seven states (Maryland, Massachusetts, North Carolina, New Jersey, New York, Pennsylvania, and Texas) have legalized these systems, and a number of other states have introduced

them in their legislatures for approval. This is an important step in advancing the status of these systems toward general acceptance, but the mere fact of having attained legal recognition will not put them automatically into universal use. Occasional surveys to define a tract of land here and there are all that can be expected in the near future.

To secure the maximum benefits from accurate land surveys, they must be prepared as coherent plans that represent the situation as a whole. In the larger cities, detailed maps are by now considered an indispensable part of the equipment for management, operation, and development purposes. In the rural areas this is far less in evidence, although similar maps, conceivably on a smaller scale, are just as much needed to promote efficient functioning of the *rural* branches of government. No doubt the cost of surveying has been one of the principal deterrents to a wider expansion of these plans. Now, however, with the use of aerial photographs and coordinate control, such plans can be constructed more rapidly at lower cost than was formerly the case. In fact, instances are known in which the benefits derived from these plans paid for them in short order. Notable discrepancies between total area and the land on the tax roll may be known but cannot be checked without maps containing individual holdings. A case in point may be cited: "In six Connecticut towns the use of such maps resulted in recovering 1,237 residences, 12,534 garages and barns, and 13,866 lots which were escaping taxation."[3]

Land use, productive capacity of the land, land conservation, land tenure, land value, taxation, etc., are all related factors beset with problems which penetrate the entire rural economic structure. All of them reach back to the land and cannot be solved without involving individual land ownership. Cadastral or land ownership plans are one of the first requisites for improvement of conditions in the Country.

As state implements of administration, cadastral surveys and register need the support of state legislative acts which go beyond a formal approval of the plane coordinate survey systems. Provisions should also be made by the States for central survey agencies to provide for technical management and counsel in their operation. In addition, these state agencies should be charged with the maintenance of an archive where the muniments of private and public land ownership as well as of institutional divisions (drainage, irrigation, conservancy, etc., districts) are kept on file, and thus can act as centers of information where copies may be obtained or consulted by other government agencies or the public.

Survey Maps of Physical and Cultural Features

For years the topographic survey of the United States has been of

[3] Air Photography for Mapping, *Pennsylvania Planning*, August, 1938.

real concern to those who must rely on the resulting maps to supply the evidence of the local physiographic setting, as well as to those who need the topographic map as a working base to record the extent in occurrence of other geographic features. As records and as working implements, topographic maps are fundamental to sound national planning and are basic to the investigation and inventory of our national resources.

Although topography occupies a preeminent position in the process of mapping the Country, land relief is only one of the factors, and by no means everywhere the most significant factor of the natural environment influencing human activities. Climate, minerals, soils, water supply, natural vegetation, present land use, land use potentiality, etc., all are factors and features that contribute in various degrees to the totality of the environmental complex and, in the aggregate, shape the condition for human occupancy. To obtain documentary evidence of the relative importance of these features in the local setting requires mapping them in their places of occurrence, classified according to significant characteristics.

In an investigational process, having as its objective the clarification of the economic-use potentiality of land, areal synthesis of the pertinent factors involved is, however, only one of the important steps for which the topographic map offers particular advantages. In an economic analysis of the local situation the qualitative aspect of the land must be determined and followed by the determination of the equally important quantitative occurrence of the different land categories. Quality and quantity of the land determine the economic land resources of an area. The first must be identified in the field, the second can be obtained only from cartometric measurements on the map. Topographic maps, derived from controlled surveys and used as bases, possess the best qualifications for the purpose.

Expounding the need of a topographic survey of the Country is to discuss a subject worn threadbare from repetition. Although the fundamental nature of these maps to many of our national activities is evident, provisions for acceleration in mapping the Country are still lacking. Progress is impeded by the present dependency on state funds to which an equal amount is added by the Federal Government. How this arrangement has worked out in practice is indicated by the distribution of surveyed areas. A few of the smaller but financially stronger and more alert states have the topographic survey completed or nearing completion, but all other states have only a scanty showing of a few quadrangle sheets. There is little hope of getting the survey of the Country completed so long as this policy prevails.

Medium- and Small-Scale Maps

Maps may be classified on the basis of a number of characteristics. We are first concerned with the over-all distinction of maps functionally

designed to implement research and study in the geographic and economic fields of investigation. The scale governs the capacity of recording detail and consequently is one of the most significant characteristics. There are, of course, no sharp divisions among the scale groups. For convenience of designation, medium-scale maps may be considered as those ranging in scale from about 1:200,000 to 1:1,000,000 and small-scale maps as those having scale ratios of more than one to a million.

Medium- and small-scale maps constitute, in some respects, a distinct mapping field. Large-scale maps are in the main the results of measurements and observations taken in the field, while medium- and small-scale maps usually are reduced compilations of judicious selections from existing source material which at times requires supplementary field work. Fixed standards in the use of projections, precision of presentation, base content, and symbols employed will accommodate most users of the large-scale topographic maps. But in the field of medium- and small-scale maps, groups of map users have distinct needs requiring the use of more than a single type of map. Geographers and land economists form one of these groups. Other groups, aviators, for instance, will have fundamentally different requirements, which include structural qualification as well as contents. But aviators, military men, and motorists, have their own maps, and the navigators have their charts. All of them have their maps and charts made to order. Geographers and economists, on the other hand, are dependent on a motley assortment of maps that in most cases are, neither in content nor in structure, functionally conceived to take care of their particular needs.

Medium- and small-scale maps, with land forms and elevation clearly expressed, contain one of the most significant correlation factors for research men in geographic subjects when the map is used as a working base. The interrelationship of natural and cultural features, when mapped in its place of actual occurrence, is clearly perceptible and provides documentary evidence.

A cursory inventory of the principal medium- and small-scale maps of the United States will reveal the equipment in this field.

Numerous medium-scale maps of states are in existence. Those published by the states are prepared mainly in the interest of the states, and in their treatment do not show uniformity in scale, contents, or execution. Sets of state maps have also been prepared by the General Land Office and the U. S. Geological Survey. These are the older official compilations published on scales of 1:760,320 and 1:500,000, respectively. Most of these maps are prepared for general use. They are drawn on different projections and individual projection planes and, even when on the same scale, cannot be assembled to produce a continuous representation wherever a regional base is desired. Moreover, land relief is usually ignored or has

received only an adumbrate rendering. Those of the state maps that contain land relief expressed in contours do not use the same contour intervals or systems of measures—feet and meters, both are used.

A systematic coverage of the United States with medium-scale maps on standard scales, containing physiographic and cultural features, is needed properly to implement subregional and regional research. Maps on two standard scales, 1:250,000 and 1:500,000, would go far to fill the want. Of these, the larger-scale map could be in the form of quadrangles, each sheet having its own projection plane, but the sheets of the smaller-scale map should be on one equal-area projection plane for the whole United States to preserve the area and permit regional composition.

Maps of this kind possess a wide range in use possibilities. Workers in the geographic and economic fields of investigation as well as the public would be benefited. In research they would be used as a working base, and would furnish the background on which other features can be presented. Land economists are in particular need of such maps. In regional research we are far more dependent on a statistical treatment and verbal description of land use than on a visual apprehension of the actual arrangement, composition, and distribution of major land uses in the area. As yet, for much of the United States, the so-called "regional land use pattern" is only a convenient figure of speech. The map of the alluvial valley of the Mississippi, prepared by the Mississippi River Commission in 1934, scale 1:250,000, is suggestive of what is needed.

That the lack of such maps is equally felt by the map-conscious citizen is attested by "A Plea for Real Maps,"[4] made some time ago. According to the author, the United States compared unfavorably with most of the European countries and, so far as the one-millionth map is concerned, even with Paraguay, South America.

When the available small-scale maps of the United States are considered, the situation is better, except when land relief is needed. We have the map of the United States published by the U. S. Geological Survey on the Albers equal-area projection, scale 1:2,500,000, and its reduced reproductions. For a good many purposes, these maps provide suitable bases on which other features can be superimposed. They are inadequate, however, for coordinating physiographic with other areal conditions.

It is evident from the preceding review that there is no dearth of maps. The lack is in maps that in structure, contents, and definite expression come up to the more exacting needs of research and investigation.

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[4] A Plea for Real Maps, Engineering News-Record, June 6, 1940.

Topographic Mapping in the Redwoods

CHALMER K. LYMAN, U. S. Forest Service

This article covers only the establishment of horizontal control of the area discussed. Concurrently with the construction of the tree stations vertical distances were determined from the platforms to a bench mark at the base of the tree and height of signals above the platform measured. These data were obtained for use in connection with the establishment of vertical control of the area. —EDITOR.

FOR YEARS, topographic mapping agencies have dreaded the thought of having to make accurate and detailed maps of the giant redwood-timbered areas in northern California. In the spring of 1942, the War Department assigned one of the worst portions of the redwoods for mapping to the United States Forest Service, Division of Maps and Surveys. The area included approximately 1,611 square miles, extending from Eureka, California, north to the Oregon state line, and from the coast inland an average of 18 miles. Mapping specifications called for a scale of 1:31,680 with a 50-foot contour interval. Limits of error were established at one-half contour interval vertically and 1/50-inch horizontally.

During the early part of May, representatives of the Washington Office and the Project Engineer made a 2-day reconnaissance trip through the area to study the country, investigate problems peculiar to that locality, and discuss the project to develop a master work plan. On the basis of this reconnaissance, it was definitely decided that the mapping could be accomplished by using the ordinary basic methods of aerial photographic surveying, but it was also obvious that rather unusual methods would be necessary to erect triangulation signals.

RECONNAISSANCE FOR CONTROL STATIONS

Because of the immense size and density of the timber, which appears as a solid, uniform mass on aerial photographs, horizontal targets had to be constructed before the pictures were taken to facilitate identification of the triangulation stations on the photographs. These targets had to be built in the tops of 175- to 250-foot trees to avoid the dark shadows that entirely obliterate all ground features on the aerial photographs. Furthermore, since stations had to be triangulated, insofar as possible, from points outside the timber, signals had to be raised well above the tops of the tallest trees so as to be visible from distances up to 30 miles. To meet these requirements, signals of the type illustrated were constructed.

To accomplish the work, a man who was both an adept woodsman and an experienced triangulator was assigned as reconnaissance engineer

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in charge. A skilled high climber was employed to rig the signals and a crew of eleven "mountain men" were made available to assist with the arduous back-packing and ground work. None but the most rugged were able to adapt themselves to the strenuous physical requirements of the work. Long, hard, cross-country hikes had to be made, with 50- to 60-pound packs, to all but 5 of the 44 tree targets built. No one can begin to appreciate the significance of this unless he makes a trip through the redwoods with a heavy pack, fighting dense and incessantly wet brush, pulling himself up over, or more often going 200 feet out of his way to get around one immense log after another, struggling to keep from slipping on the loose soil of steep slopes, and falling into unseen holes or tripping on vines and sticks hidden in the dense ferns.

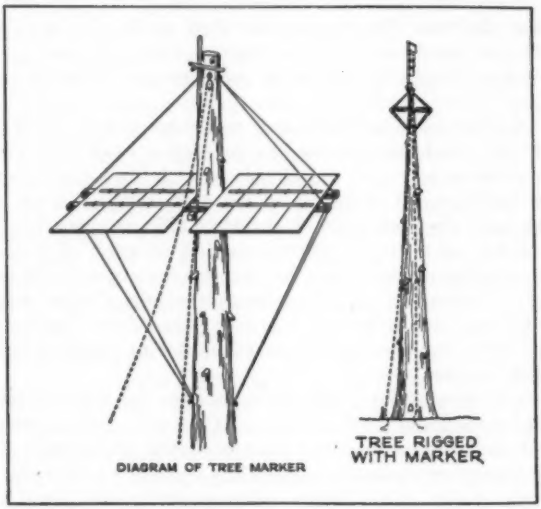
The task of scouting out station locations where the signals would be visible for observing required the utmost in resourcefulness and imagination. During all the foot travel involved, maximum visibility was rarely more than a few hundred feet in any direction. In no cases were distant triangulation stations visible from the ground where signals were located. The peculiar "jumbled" topography, together with the limited visibility and dense fog made it very hard for one to keep oneself accurately oriented. Even the best woodsman could get "turned around." The reconnaissance engineer used "everything in the book," including pacing, compass, maps, and old aerial photographs. Even then, he had to rely almost entirely on instinct when locating some stations. Yet in the end, every signal was situated where it could be observed from at least three primary triangulation stations.

To accomplish the reconnaissance work, 3 days were first spent in traveling to high, open stations where the timbered country could be studied in order to become familiar with the topography and to select the general position for each station. From then on the job consisted of selecting the definite site and the specific tree. In choosing the tree to be used, several factors had to be considered: First, the tree had to be near enough the height of the tallest in the stand so that a flag could be raised above the tops of all surrounding trees. This in itself was difficult, for the relative heights in such dense stands were hard to judge. Second, the horizontal target had to be located in a tree where it would be in full sunlight at all hours when the photographs would be taken. Finally, it was desirable to minimize the hazards and difficulties of climbing by selecting the trees with sound tops, single boles, and a minimum of large branches. After a tree was located, the best travel route was selected and marked with cruiser twine.

Constructing Signals

Between 350 and 400 pounds of equipment and materials were re-

quired to build the platforms illustrated. Because of this and the fact that all but one of the 44 stations were off the road, eight men in addition to the high climber had to be employed to back-pack the heavy equipment. Three others were hired to back-pack bedding and food to the climbing crew at the many stations which required an overnight stay because of lengthy travel time from the nearest roads. A few stations were so inaccessible that the packers could not get in to them in one day's travel.



White Plywood Tree Marker in Redwood Tree

As shelter from the wet foggy weather at overnight camps, the crews ordinarily used big hollow trees. On one occasion a hollow tree was found large enough for four men to sleep in a circle around a fire with enough room left for two more beds.

The technique developed for rigging the high platform signals is thought to be entirely new to the field of photogrammetric engineering. The methods used in rigging the first tree, the most difficult one of all, are being described. This tree was approximately 18 feet in diameter at the base. It was so large, in fact, that the climber's 1¼-inch, 50-foot, steel-core safety rope would not reach entirely around the base. The climber had to go up the tree about 10 feet before he could flip the loose end of

the rope around far enough to attach it to his safety belt. He went up the first 50 feet, where there were no limbs, in less than 5 minutes. From then on he worked steadily for 5 hours, cutting many large limbs, and topping the tree at about 230 feet above ground where the diameter had tapered down to 12 inches.

The job of topping a tree is dangerous for the climber but interesting to watch from the ground. Any one of several things can happen to make the top fall the wrong way and smash the climber as it drops. Sometimes the trunk will split open tightening the safety rope and crushing him against the tree. There is a real thrill in hearing a climber yell, "Timber!" and, watching one of the big tops fall to the ground, and seeing the climber clinging to the top of the spar as it violently sways back and forth.

After climbing and topping the first tree, 4 hours were spent in rigging the signal. A ¼-inch line, attached to the climber's belt and taken up the tree as he climbed, was used to pull up a snatch block and a larger rope. The block was fastened at the top of the spar with a railroad spike and cable. The rope threaded through the block was then used to hoist the flagpole, lumber, and other equipment needed. A crew of four men was used to accomplish all that could be done on the ground and to pull the equipment up. After the signal was completed, the climber was lowered with the block and line. The rope was then pulled down, leaving the block in the tree. This practice was followed in order to conserve the precious energy of the climber.

The average cost of these high platform flags was approximately $138. Costs varied from about $100 for a few of the easy and accessible signals constructed, to $245 for the most difficult of the flags made. These unusual cost figures are probably higher than for any fourth-order triangulation signals ever erected. Thirty dollars might be considered as an excessive cost for the usual fourth-order flags in timbered mountainous country. The unusual costs in this case are indicative of the extreme difficulties encountered on this job.

Because of the strenuous, time-consuming efforts involved in climbing and rigging a tree, no more than one signal could possibly be constructed in 1 day. The job of packing equipment was so organized that the climbers worked without interruption as fast as they could get from one station to another.

The platform signals were completed during the middle part of July. For a month after that the climber and a three-man crew were kept busy setting high tree flags within the redwood belt at points which could be identified on the aerial photographs. These flags cost an average of approximately $40. This cost compares with an average of $50 for tree flags set in smaller and easier trees on another portion of the unit by two-

man crews inexperienced in both climbing and woodsmanship, reveals evidence that the cheapest way of setting high tree flags in difficult country is (1) to have an experienced control man who is a good woodsman do the reconnaissance work, and (2) to employ a capable high climber to erect the flags.

Observing

The triangulation was accomplished using 1-minute transits and 10-second theodolites. Planetables were not used, principally because of the distances from which signals had to be observed. Several of the flags were cut in from a distance of 20 to 30 miles. The unusually large size of the flags and the care taken to elevate them well above the tops of surrounding trees made it possible to pick them up readily with a telescope at the maximum distances during average conditions of visibility. Small, carelessly set flags could not have been observed.

The job of cutting in the high tree stations was materially delayed by the presence of dense fog extending inland from the coast 1 to 12 miles every day between the middle of August and the latter part of September. Special return trips had to be made to six inland observing stations before all of these flags could be cut in.

Because of the arrangement of topography and vegetation, several of the redwood flags had to be triangulated from Redding Rock, a small rock island lying 6 miles off the coast, and from a specially constructed observing platform built in the top of a high redwood. The combination of clear weather and calm sea essential for the ocean trip to Redding Rock occurred on only 3 days between the middle of August and the last of October. One unsuccessful trip was made when fog came in to obstruct visibility several hours after the boat had left port. On the second trip three men managed to get on the rock early one morning after a night of seasickness while anchored nearby.

The job of transferring men and equipment from the small skiff up to the ladder on the sheer face of the rock while the ocean swell raised and lowered the level of the water 12 to 15 feet was no small task. Although after getting on the rock, the visibility was somewhat less than mediocre, enough angles were turned to complete the work that was absolutely essential.

The high-tree observing platform was built in order to cut in several high flags important to the continuous and adequate extension of horizontal control within the redwood timber area. The height of instrument on this platform was a little over 215 feet. This is thought to be the highest observing platform ever used solely for triangulation purposes. The platform was constructed using practically the same methods developed for building the white tree markers. The tree was guyed from just below the

platform with ½-inch steel cable, tightened with the use of blocks and line, powered by a truck. The four corners of the platform were guyed with number 9 iron wire to minimize the twisting motion created by the weaving of the trunk. Although all of the sway was not eliminated, the platform was stable enough so that when the observing crew stood perfectly still, angles could be turned with accuracy sufficient for fourth-and even third-order accuracy.

Men were pulled into the tree by a ground crew of five using a number 8 block and a ¾-inch rope. This provided an unusual thrill for the men going up, particularly when the ground crew unexpectedly let them drop a few feet when they were dangling about 150 feet in the air.

The station cost a little more than $300, including the cost of pulling the men into the tree. A portion of this cost was absorbed in scouting out the proper site. Several trees over 200 feet in height had to be climbed in different localities before the right one was found. With the necessary equipment on hand and with an experienced construction crew a similar station could probably be built for less than $100.

Identification

The 6- by 14-foot white tree platforms were readily seen on the aerial photographs, which had a scale of 1:24,000, but a knowledge of their general position greatly facilitated their identification. For the high tree flags set without white platforms, ground targets were constructed to avoid the need of making a return trip for identification purposes. Several important lessons were learned concerning the best kinds of targets to use in various types of vegetation in similar country when photographs with a 1:24,000 scale are used:

(1) In dense brush or reproduction adjacent to stands of tall timber, two strips cleared in the shape of a "V" are adequate if accurately shaped and at least 8 feet wide by 60 feet long. For very tall timber longer strips must be cleared to avoid the area which might be hidden on the photographs by trees. For lone trees surrounded by dense brush a slashed cross is best. The arms of the cross should be at least 6 feet wide and extend out from the center 20 to 60 feet depending upon the height of the flagged tree.

(2) In open grass, scattered low brush, and sparse timber with relatively bare ground, a strip of white cloth at least 3 by 12 feet, is most efficient where there is no range stock, providing it can be placed where no shadows strike it and where it will not be hidden on the photographs by tree tops. White lime is an efficient substitute but is more costly if necessary to carry it more than a few hundred feet from the road.

(3) On average ground sparsely covered with grass or in light bare soil, trenches up to 12 inches in depth cannot be distinguished on normal

clear photographs by the average picture pointer without returning to the site of the marker.

(4) On cured grass lands, dead limbs or weathered boards do not make an effective target.

Conclusion

The high average cost of approximately $30 per square mile for this part of the horizontal control work should be attributed mainly to the unusual obstacle encountered rather than to any inefficiency and incompetence on the part of field men who did the actual work. Because of the adverse conditions created by the composite influence of vegetation, topography, weather, and lack of roads and trails, this is asserted to be one of the most difficult jobs of fourth-order triangulation ever undertaken in the United States.

This account would not be complete without a tribute to the men who accomplished the job. They worked conscientiously and arduously to overcome all obstacles and complete the field work without selfish and unnecessary thought of personal comfort. They adhered closely to the worthwhile objectives of the program, the expeditious development of an accurate map which would be of value to the war effort in particular and to the national welfare in general.

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MAPPING IN THE SOLOMONS

". . . Detailed experiences of army mapmakers in the Solomons cannot yet be wholly revealed, but when they are told they will pack a book with adventure and thrills. Daring surveyors, sneaking ashore at night on Jap-held islands, have made complete transit and level surveys in broad daylight, protected from Japanese patrol parties only by warnings of the natives.

"A striking exploit of this sort was the work of a Colonel Beadle and a party of engineers who landed on Vella Lavella in July 1943 before Americans captured the island from the Japanese. The engineers, landing at night in a rubber boat sent out from a PT, were on the lookout for an airstrip site. For more than a week the party surveyed likely spots and made detailed maps of a section of the island best suited for invasion. When Jap patrols approached, the natives gave pre-arranged warnings and the surveyors gathered their instruments and took to the bush. Maps made by this party paved the way for airstrips and a quick, successful landing."

—Frank Henry in *The Baltimore Sun*, June 4, 1944.

The Ballad of Charlie McCoffus

By Walter S. Dix

(With Apologies to "Anonymous")

A field engineer named Charlie McCoffus,
Worked all day in the field and at night in the office,
Checking traverse and levels and topography too,
To be picked to bits by the Main Office Crew.

For the Main Office boys, in their double-lens specs,
Their sallow complexions and fried collar necks,
Care not for the labor nor the legwork they waste;
If a contour is missing, a spot shot misplaced,
They bounce back the sheet with ill-concealed jeers,
To harass the hard-working field engineers.

To get back to Charlie, he struggled along,
'Til an ache in his head told him something was wrong;
He went to the Doctor, and "Doctor," said he,
"There's a buzz in my brain; what's the matter with me?"

Well, the medico thumped, as medicos do,
And he tested his pulse and his reflexes too,
And his head and his heart and his throat and each lung,
And Charlie said "ah" and stuck out his tongue,
The Doctor said, "God, what a narrow escape,
But a quick operation will put you in shape."

"Your brain's overworked like a motor run down,
And you're flirting with death every time you turn 'round.
I must take out your brain for complete overhauling,
In the interim take a respite from your calling."

So Charlie McCoffus went under the knife,
He struggled home brainless and kissed his own wife,
While old Dr. Quack and two other men
Were putting his brain back in order again.
Well, the weeks rolled along and Charlie McCoffus
Never called for his brain at the medico's office.

The Doctor got worried, gave Charlie a ring,
Said, "You'd better come over and get the damned thing."
"Thanks, Doc, I don't need it," said Charlie McCoffus,
"I've just been transferred into the Main Office."

So Charlie now wears a fried collar to work
And he hides in the lairs where the auditor's lurk,
And his letters bring tremors of anger and fear,
To the heart of each hard-working field engineer,
While the pride and the joy of the old Main Office
Is brainless, predacious, old Charlie McCoffus.

Reprinted through the courtesy of The Set-Up, April 1944.

Comment and Discussion

SURVEYING AND MAPPING will welcome comments and discussions of any matter pertaining to the interests of the Congress. —EDITOR.

Planetable Versus Transit

DISCUSSION

BY D. D. HAINES AND E. P. BAUER

HAINES, D. D.*—The article by M. F. Denault entitled "Planetable Versus Transit for Topographic Mapping" which appeared in the July issue of SURVEYING AND MAPPING deserves some discussion. One would think, from the title, that the pros and cons would be presented for both instruments. However, such is not the case. It is easily seen that Mr. Denault favors the planetable so thoroughly that his entire article is prejudiced in its favor—a trait which he says exists against the use of the planetable for making topographic maps "among a large percentage of engineers engaged in various surveying capacities." I have no brief for the transit alone, neither have I one for the planetable, but in arguments such as this both sides should be presented and justice done.

It is doubtful if the prejudice that Mr. Denault infers actually exists toward the planetable. If such prejudice does exist, it most likely is not due to the reasons given by the author. He would lead one to believe that small groups, probably including many private surveyors, do not use the planetable because they do not know that it exists. Most likely the planetable is not readily available to these groups. Certainly an alidade is not usually owned by the small private surveyor. On the other hand, he very probably would have a transit.

Surely the larger surveying companies are not reluctant to give the planetable an opportunity to prove itself. This statement cannot, of course, be proved; neither can Mr. Denault prove his contrary statement. Not all topographic mapping jobs are particularly adapted to the use of the planetable. Under favorable conditions the larger companies probably would use the planetable provided an experienced planetable man could be found —a condition not easily fulfilled.

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* Associate Professor of Civil Engineering, University of Kansas.

The cost of a survey must always be considered. It costs more to maintain a man in the field than at home in the office, even if on the same monthly salary. Besides, semi-skilled office help usually can be hired for less than equally dependable field helpers. No, it hardly seems probable that the larger companies are just stubborn about using the planetable. They honestly believe that the transit survey can be made at lower cost.

The planetable is particularly useful in taking minute details. Yet the author infers that this is the very reason why the "more progressive" utility groups do not make more use of the planetable. This should be a strong argument for the planetable's use.

The author is correct in his statement that the most common method used on topographic surveys when a transit is used is the controlling point method as described in (2) under the heading "Purpose of Topographic Maps." The last line now reads, "All contours, culture, and detail are sketched in the *office.*" This need not be so. After the transit-stadia data have been plotted on the sheet by the draftsman, the map should be taken to the *field,* preferably by one of the original survey party but not necessarily so, to sketch in all details, culture, and contours. This is a modification of the method that Mr. Denault speaks of as the *Baltimore method.* If this method is followed it reduces by about 50 percent the number of sights which otherwise would have to be taken to controlling points to determine ground relief. Therefore, it is not true that "in using the transit almost twice as many shots must be observed." If the map is taken to the field to sketch contours and details then approximately the same number of sights would be taken with either a transit or planetable to cover a given area. This method is not uncommon. It has been taught to all students taking topographic surveying and mapping at Kansas University for the past 30 years.

The writer agrees with the author that the planetable is useful for graphic triangulation. It is also true that when used by an experienced man some time is undoubtedly saved in reducing and plotting data. Many topographic surveys are made during the rainy season. A transit can be used successfully between showers to gather enough data to keep the party busy during rainy stages. On the other hand, the planetable party cannot work during showers; neither can it work to much advantage on very windy days.

If Mr. Denault feels that the Beaman arc is an advantage over the vertical circle as usually found on transits, he should not lose sight of the fact that for those who prefer it the arc can be installed on the usual engineer's transit at a very nominal cost.

In most other respects Mr. Denault's article is sound. The strongest

statement made in behalf of the planetable is found opposite the picture in which he says, "The peculiar advantages of a planetable are most apparent in mapping rough country. The planetabler maps as he surveys." Undoubtedly Mr. Denault is a planetabler or he would not argue so strongly for it. Others are only transitmen, and in the interest of accuracy, since they know but little about the planetable and alidade, they continue to use that with which they are most familiar.

Both the planetable and the transit have their place in topographic surveying. Both have their strong points and their weak points under certain circumstances. Therefore, insofar as possible, let the circumstance decide which shall be used on any survey, after giving due consideration to each.

BAUER, E. P. *—In the article "Plane Table Versus Transit for Topographic Mapping," M. F. Denault has brought out some strong arguments in favor of the planetable as a topographic tool. For medium- and small-scale mapping, the planetable is generally the preferable instrument; however, the planetable—or perhaps I should say the planetable topographer—is not well adapted to certain specialized types of mapping.

The trained planetable topographer establishes the "bony structure" of the terrain before him by means of a minimum number of stadia shots strategically placed along ridge and valley lines, makes the necessary interpolations, and then—very skillfully—sketches in the contours. The result is a highly recognizable picture of the terrain, achieved by use of the same technique that is employed by the caricaturist—the subtle, and often unconscious, exaggeration of detail. The above procedure is entirely proper, when used on small-scale maps made for preliminary and qualitative studies of the engineering possibilities of an area; but when the same procedure is used on medium- and large-scale maps, to provide quantitative data, the results are always inaccurate and often entirely misleading.

Contours on site topography, to be of value at all, must be as accurately drawn as the scale of the map permits. A frequently used criterion of accuracy requires that one should be able to determine the elevation of any given point on the map with an error amounting to less than one-third of the contour interval of the map. We have learned in descriptive geometry that any warped surface may be approximated by fitting a sufficient number of plane triangles to it.

The problem in site topography is to choose the location of the shots so that they form the vertices of adjoining plane triangles that fit the

* Reprinted through the courtesy of Engineering News-Record, August 24, 1944.

ground surface closely enough to conform to the criterion cited above. If the shots are so located, and the sides of the triangles are penciled in on the map, straightline interpolations may properly be made along any of the sides. The task of drawing the contours through such a network of shots is purely a graphical one; it may be done in the field on the planetable, in the office on the planetable sheet, or in the office on a map plotted from the transit field notes; the results will be the same in any case. For this type of work, because of its greater speed, the transit is superior to the planetable.

For types of work within the proper sphere of the planetable, I have used the combined planetable and transit method of taking topography, and prefer it to either of the two conventional methods. In the combined method, the two instruments are set up about 6 feet apart, the stadia shots are read and reduced by the transitman, while the planetable man aligns an open-sight alidade on the rod, and plots the called distance and elevation. The eccentricity of the two instruments is disregarded on small-scale work, and corrected by simple graphical methods on large-scale mapping. The method effects a better distribution of labor between the two members of the instrument team, and also takes advantage of the faster pointing of the transit telescope. The method shows to best advantage on medium-scale work, being about 20 percent faster than the conventional planetable method on such work.

Mr. Denault's paper demonstrates his intimate knowledge of modern planetable procedure, but leads one to believe that he is not so intimately acquainted with the best modern practice of the transit method. The office method of plotting transit notes, described in his paper, has been obsolete for the past 20 years; and it has been fully 15 years since I have seen any organization, that made a pretense of being equipped for topographic mapping, use any instrument other than the drafting machine for plotting transit topography. With the drafting machine, the hand and eye of the draftsman are the only factors that limit accuracy in plotting, and these same factors limit the accuracy of planetable plotting in exactly equal measure.

A CASE OF MISTAKEN IDENTITIES

In a recent article in an aviation magazine, the following statement appeared:

"Another great difference between U. S. and British maps is the projection from which they are made. U. S. Sectional and Regionals are Lambert conformal pro-

jections, with distance measured from mid-latitude in nautical miles. British maps are modified polyconic projections with a constant scale measured in statute miles. This I found to be an asset after I learned to work with statute miles instead of knots, but this change-over took time."

The author is evidently confusing the Lambert conformal projection with the Mercator projection. The U. S. Sectional and Regional aeronautical charts *are* constructed on the Lambert projection, but distance is *not* measured from mid-latitude in nautical miles. In fact one of the principal reasons for the adoption of this projection is the practical uniformity of scale throughout the chart, which permits the use of a graphic scale in statute miles, as well as nautical miles. The Mercator projection, on the other hand, has a progressively varying scale as one recedes north or south from the standard parallel of the chart, on which the scale is true. In measuring distances on this projection, therefore, the scale at the mid-latitude of the track must be used. —A. L. S.

"SURVEYING AND MAPPING" IN SPANISH?

From a letter to President Whitmore:

"It is a pleasure to let you know that it was with great satisfaction that I received the January issue of the BULLETIN of the American Congress on Surveying & Mapping which has reminded me so much of the memorable September meeting held in Washington.

Of course, as you know, Mr. President, I cannot enjoy all of its sound and interesting reading which on trying to translate loses part of its originality. I would suggest to you, how beneficial it would be to Latin American readers if the BULLETIN would be printed in Spanish, as well as in English."

GENERAL EDUARDO ZUBIA, *Director,*
Instituto Geografico Militar, Uruguay.

PRESIDENT WHITMORE IN BRAZIL

AS A RESULT of the interchange of ideas and information which has characterized the international meetings of the Commission on Cartography of the Pan American Institute of Geography and History, President Whitmore has gone to Brazil, at the request of the Brazilian Government, to assist in the reorganization and consolidation of their Photogrammetric Services.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

VALUE OF AIR PHOTOGRAPHS IN SOLVING CIVIC PROBLEMS. *Pennsylvania Planning*, February 1944. (Letter from chairman of Crawford County Commissioners, explaining various aids and economies developed in County through use of air photographs.)

REALIGNMENT OF RAILWAY CURVES WITHOUT ALTERATION OF LENGTH OF ROUTE. G. J. Thornton-Smith, *The Australian Surveyor*, March 1944. (Demonstrates formulas used to calculate the position of the new curve.)

PLANNING AND MAPPING—1944. Ralph Wesley Jones, *Excavating Engineer*, April 1944. (Describes the Brock-Weymouth stereoscopic plotting method and how aerial photography in general can be utilized now for getting engineering data for postwar planning.)

THE FIRST GRAPHIC ART. David Greenhood, *News Letter* (of the American Institute of Graphic Arts), June 1944. (Describes map making as the oldest of the graphic arts and emphasizes the effect of printing on the development of the map.)

GEOPHYSICAL MEASUREMENTS IN THE AMERICAN REPUBLICS. L. O. Colbert, *The Scientific Monthly*, June 1944. (Describes the cooperative work—tidal, magnetic, and gravity—of the U. S. Coast and Geodetic Survey in the American republics under the Department of State program.)

OBSERVATORY RECORDS REVEAL MAGNETIC STORMS. J. H. Nelson, *Civil Engineering*, June 1944. (Describes methods used at the U. S. Coast and Geodetic Survey's magnetic observatories to measure the strength and direction of the earth's magnetic field; explains application to surveying, especially in retracing old boundary lines.)

RATIO AND APPROXIMATE TILT DETERMINATION FOR PHOTO MOSAICS. Army Map Service, *Photogrammetric Engineering*, June 1944. (Describes the recently developed Ratiograph for determining point ratios on aerial photographs with relation to the same positions on the assembly base.)

AERIAL PHOTOGRAPHY AS A MAP SUBSTITUTE. Louis A. Woodward, *Photogrammetric Engineering*, June 1944. (Describes the procurement and use of aerial photographs in the United States, with particular emphasis on the methods of the Department of Agriculture and on the specifications included in the contracts it awards.)

THE PROGRESS OF THE PHOTOGRAPHIC SURVEYING METHOD. J. A. Flemer, *Photogrammetric Engineering*, June 1944. (Originally published in November 1899, this article shows that the first practical application of the principles of photographic surveying was made as far back as 1791.)

AERO-TRIANGULATION. Theodore H. Drummond, *Photogrammetric Engineering*, June 1944. (Describes a process of obtaining ground control by using two airplanes—each equipped with three aerial cameras on gyroscope-controlled mounts—the known distance between them being used as the base for triangulations.)

POSTWAR PHOTOGRAMMETRY IN THE UNITED STATES. George D. Whitmore. *Photogrammetric Engineering*, June 1944. (Discusses the probable postwar attitude towards mapping; the necessity for planning now; and the capacity of the photogrammetric profession to absorb an expanded program.)

THE BALDWIN SOLAR CHART. D. H. Baldwin, *Photogrammetric Engineering*, June 1944. (Describes the 1943 edition of the "Solar Azimuth Chart" used to orient the planetable in areas where a compass needle does not serve.)

NUMERICAL THREE-POINT SOLUTIONS. John B. Mertie, Jr., *Photogrammetric Engineering*, June 1944. (Describes two algebraic solutions of the three-point problem—one for coplanar angles and the other for spherical angles.)

SITE OF THE SMITH MASSACRE. Lancaster Pollard, *Oregon Historical Quarterly*, June 1944. (The exact location on the Umpqua River, Oregon, where the massacre of July 14, 1828 took place has been cleared up through entries in the field notebook of a land surveyor on a surveying trip made in 1857-58.)

AERIAL PHOTOS MAP ROUTE FOR TRANSCONTINENTAL TELEPHONE CABLES. J. L. Berggren, *Civil Engineering*, July 1944. (Describes the use of aerial photographs in mapping the route for telephone cables between Omaha, Nebraska, and Sacramento, California.)

THE JIG COLLIMATOR. George A. Greenewald, Jr., *Aero Digest*, July 1, 1944. Describes the adaptation of the surveyor's transit to aircraft tooling.)

PHOTOGRAPHY SIMPLIFIES TRIMETRIC DRAWING TECHNIQUE. W. G. Wilkinson and H. C. Bartholomew, *Aero Digest*, July 1, 1944. (Describes method and equipment used in photographically translating a conventional orthographic drawing into a three-dimensional drawing for use in production illustration.)

GRID NAVIGATION. Samuel Herrick, *Geographical Review*, July 1944. (Explains how by superimposing a rectangular grid system on a conformal chart it becomes possible to use it for straightline navigation in the same way as a Mercator chart is used.)

AERIAL RECONNAISSANCE FOR TRIANGULATION. J. L. Rannie, *Empire Survey Review*, July 1944. (Describes the methods and equipment used in aerial reconnaissance in Canada.)

AZIMUTH COMPUTATION IN THE OLD PRINCIPAL TRIANGULATION OF THE BRITISH ISLES. H. L. P. Jolly, *Empire Survey Review*, July 1944. (Investigates reasons for discrepancies in azimuth computations in the Principal Triangulation.)

SAFEGUARDING LIFE AT SEA. Gilbert T. Rude, *The Military Engineer*, July 1944. (Describes modern hydrographic surveying and what it has meant in safeguarding life and property at sea.)

MILITARY MAPPING IN THE SOLOMON ISLANDS. Joseph C. Partington and Norman Porter, *The Military Engineer*, July 1944. (Describes procedure used in making hasty terrain maps and photomaps and the usefulness of each.)

CANADA'S PROGRESS IN AIR NAVIGATION CHARTING. B. W. Waugh, *The Canadian Surveyor*, July 1944. (Describes the various types of charts used in air navigation.)

STANDARD CONDITIONS FOR THE USE OF STEEL TAPES. R. W. Boyle, *The Canadian Surveyor*, July 1944. (The National Research Council, Ottawa, would welcome the opinions of responsible surveyors and others on the proposal that 20° C. (68° F.) be employed in Canada as the standard reference temperature for steel tapes.)

THE FIRST AIR CAMERA CALIBRATION IN CANADA. R. H. Field, *The Canadian Surveyor*, July 1944. (Describes the methods of calibration used in the 1920's.)

AZIMUTH FROM DIRECT SOLAR OBSERVATIONS BY THE METHOD OF HAVERSINES. Wm. H. Brady, *The Canadian Surveyor*, July 1944. (Gives formula and example for use by land surveyors.)

USE OF AERIAL PHOTOGRAPHS IN HIGHWAY LOCATION AND DESIGN. Frank E. Bosland, *The University of Tennessee Record*, July 1944. (Gives information about the use of photographs and photographic mosaics by highway location engineers to insure exhaustion of location possibilities.)

THE ORIGIN OF OUR STATE NAMES. John P. Harrington, *Journal of the Washington Academy of Sciences*, August 1944. (A preliminary, curtailed version of the author's extensive collections on this subject.)

HOW THE WAR MAPS ARE MADE. C. Lester Walker, *Harper's*, August 1944. (Contains statistics on the number of maps used in the North African and European invasions.)

A COMBINATION OF SURVEYING METHODS IS BEST. Paul Van Buskirk, *Engineering News-Record*, August 24, 1944. (Discusses the advisability of using a combination of the transit and the planetable in surveying projects.)

BOOKS

AERIAL PHOTOGRAPHS AND THEIR APPLICATIONS. H. T. U. Smith. *D. Appleton-Century Company*, New York. 1943. 372 pages. (Covers the basic principles of photogrammetry including photo-interpretation and a concise summary of military applications.)

THE FLOOR OF THE OCEAN. Reginald A. Daly. *The University of North Carolina Press*, Chapel Hill. 1942. 177 pages. $2.50. (The results of several recent geophysical investigations presented and included in three chapters: The foundations of the Great Deep; Submarine mountains; and Continental terraces and submarine valleys.)

LOOK AT THE WORLD: The Fortune Atlas for World Strategy. Richard Edes Harrison. *Alfred A. Knopf*, New York. $3.50. (Attention is focused on the global and geographical relationships of the world rather than on matters of population, etc.)

GRAPHICAL SOLUTIONS. C. O. Mackey. *John Wiley & Sons*, New York, Second edition. 1944. 152 pages. Charts and tables. $2.50. (Provides instruction in the construction and application of curves, diagrams, and charts for the graphical and mechanical solution of engineering problems.)

LUMINESCENCE OF LIQUIDS AND SOLIDS. Peter Pringsheim and Marcel Fogel. 201 pages. Illustrated with half-tones and line drawings. $4.10 postpaid. (Surveys historical and theoretical background of luminescence, and deals with practical applications in a number of fields.)

WORLD MAPS AND GLOBES. Irving Fisher and O. M. Miller. *Essential Books*. $2.50. (Discussion of the various kinds of maps and how to judge them. A new method is described for spotting the distortion in flat maps.)

BOOKS RECEIVED

HYDROGRAPHIC MANUAL (U. S. Coast and Geodetic Survey). Commander K. T. Adams. *U. S. Government Printing Office*, Washington, D. C. 940 pages. $2.75. (To be reviewed in a later issue of SURVEYING AND MAPPING.)

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Book Review

DOWN TO EARTH: MAPPING FOR EVERYBODY. David Greenhood *Holiday House*, New York. 1944. 262 pages. $4.00.

LIKE THE WRITER OF HOLY WRIT, the author of this book *might* have begun by saying, "Forasmuch as many have taken in hand. . . . I thought it well" to write a treatise also. Instead, he begins: "As we stand on the moon, looking at the earth!"

In these days of global interests, many books on maps have appeared, but the results have not always been all that might be desired. Here is a book that is easy to look at (the illustrations are excellent) and its colorful style makes it easy to read. The author has succeeded to an unusual degree in humanizing cartography and in bringing mapping "down to earth" for just about everybody.

The book is well balanced in treatment, being divided into three parts: (1) Getting the most out of maps; (2) Making your own; and (3) Forming a collection. The individual parts will have their special appeal, while together they constitute a very pleasant approach to the whole field of cartography.

Many of the more complicated subjects are explained so simply that one cannot miss the basic principles. More study, of course, would be required in order to actually practice the art described. For example, all of photogrammetry is covered in about four pages.

In places, there is a tendency to over-simplification, with some resulting inaccuracies. Only a few of these are serious: for example, it is stated that in the gnomonic projection centered on the Equator, the parallels of latitude are "arcs of non-concentric circles," whereas they are conic sections.

But these few errors should not be allowed to detract from a really worth-while contribution, which should do much to promote a knowledge of the earth on which we live (geography) and of the problems of representing it (cartography).

U. S. Coast & Geodetic Survey. THOBURN C. LYON.

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THE LONGEST TRIANGULATION ARC

DURING THE PAST SUMMER the U. S. Coast and Geodetic Survey has extended triangulation from Port Clarence, Seward Peninsula, westward to the Little Diomede Island in Bering Strait. Triangulation has also been accomplished between Wide Bay and Chignik Bay, Alaska Peninsula.

The completion of these two arcs permits the extension of the North American datum of 1927 into western Alaska and the Aleutian Island chain.

Triangulation is now continuous from the lower end of Mexico through the United States, Canada, Yukon Territory, western Alaska, to the Little Diomede Island, and via Cook Inlet and the Alaska Peninsula to Tanaga Island at longitude 178° West in the Aleutian Island chain. This represents over 6000 miles of continuous triangulation and probably is the longest arc extant.

Stations established on the Little Diomede Island have been selected so that connections can be made to the control of the Soviet Government at such time as their triangulation is carried from Siberia to the Bering Strait.

—H. W. H.

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THE MAPS OF BERLIN used by the Royal Canadian Air Force when bombing that city show the strategic buildings by their street addresses, which the R. C. A. F. obtained from a Berlin classified telephone directory borrowed from the New York Public Library.—*Colliers,* January 8, 1944.

CONGRESS NEWS

NEW MEMBERS

AMMANN, JACK
Owner and Genl. Mgr., Jack Ammann, Photogram. Engrs., San Antonio, Tex.

BALES, (MRS.) KITTY T.
Asst. Engr. Draftsman, TVA, 411 Old Post Office Bldg., Chattanooga

BLAKE, PAUL
Associate Topographic Engineer, U. S. Geol. Survey, Arlington, Va.

BRITAIN, KENNETH E.
Civil Engr., The Pure Oil Company, 2821 Rosedale, Houston 4, Texas

BROWNING, R. GETTY
Ch. Locating Engr., State Highway & Public Works Comm., Raleigh, N. C.

BRUDER, WALLACE A.
Associate Cartographic Engineer, U. S. Coast & Geodetic Survey

CHESTON, CHARLES E.
Prof., Dept. For. & Engr., The Univ. of the South, Sewanee, Tennessee

COOL, FRANK J.
Topographic Engineer, U. S. Forest Service, Missoula, Montana

COON, EMMETT J.
Associate Topographic Engineer, U. S. Geol. Survey, Arlington, Va.

ELDRIDGE, HENRY M.
Senior Engineering Aide, TVA, 805 Pound Bldg., Chattanooga, Tenn.

ESHBAUGH, CLIFFORD WAYNE
Instr., Dept. of Civil Engineering, Missouri School of Mines, Rolla, Mo.

FAIR, LOWELL D.
Senior Engineering Aide, U. S. Coast & Geodetic Survey, Washington, D. C.

GILL, WILLIAM H.
Capt., Ch. Office of Map Information, U. S. Geological Surv., Wash., D. C.

HAMMOND, (MISS) MARY T.
Assistant Engineering Draftsman, TVA, 7 Ridgeside Road, Chattanooga, Tenn.

HANNEMA, D. P.
Sergt., Netherlands Military Comm., 2010 Mass. Ave., N. W., Wash., D. C.

HINLEY, J. ANDREW
Prin., Engineering Aide, U. S. Coast & Geodetic Survey, Washington, D. C.

HINNANT, D. FRANKLIN, JR.
Engineering Aide, TVA, 201 Pound Building, Chattanooga, Tennessee

JOHNSTON, (MISS) ANNE
Assistant Engineering Draftsman, TVA, 7 Ridgeside Road, Chattanooga, Tenn.

KIFF, GLENN P.
Head Engr., Mapping Sect., R. E. A., Boatmen's Bank Bldg., St. Louis, Mo.

LARNER, FRANK
Associate Topographic Engineer, U. S. Geological Surv., Wash., D. C.

MOORE, ROLAND H.
Associate Topographic Engineer, U. S. Geol. Survey, Arlington, Va.

RANDALL, GERALD C.
Senior Engineering Aide, U. S. Coast & Geodetic Survey, Wash., D. C.

RICHARDS, (MISS) MARGARET A.
Assistant Engineering Draftsman, TVA, 509 Walnut St., Chattanooga, Tenn.

RIGG, BENJAMIN H.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Atlanta, Georgia

RUFF, DAN GEORGE
Prin., Engr. Aide, Tenn. Valley Auth., 3214 Duncan Street, Columbia, S. C.

SMITH, ALBERT
Chief Draftsman, Div. of Drafting, U. S. Forest Service, Atlanta 3, Ga.

SMITH, STANLEY G.
Office Engineer, Engineering Dept., Magnolia Petroleum Co., Dallas, Texas

SOBIERALSKI, V. RALPH
Lieutenant, U. S. Coast & Geodetic Survey, Seattle, Washington

SPRY, (MISS) DORIS
Asst. Engr. Draftsman, TVA, 409 Old Post Office Bldg., Chattanooga, Tenn.

STRAMLER, J. W.
Title Surveying Eng., Stanolind Oil Co., 1504 Nashua, Houston, Texas

STRIKER, ARTHUR F.
Civil Engineer,
Map Editor, TVA, Chattanooga, Tenn.

STRODE, GORDON RAY
Recorder, U. S. Coast and Geodetic Survey, Spencer, West Virginia

STUDDARD, (MISS) MARY C.
Assistant Engineering Draftsman, TVA, 411 Old Post Office Bldg., Chattanooga

SWEET, A. J.
Lieut. Colonel, Military Intelligence Division, Pentagon Bldg., Wash., D. C.

WHITE, LEON VINCENT
Prof., Dept. Civil Engr., Kansas State Agricultural College, Manhattan, Kans.

ZUBIA, EDUARDO
General, Director Instituto Geografico Militar, Montevideo, Uruguay

LIBRARY MEMBERSHIPS

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"SURVEYING AND MAPPING" GETS A BOOST

WE DON'T USUALLY TAKE NOTICE specifically of additions to the Congress roster, but when six of the gentler sex in one fell swoop come knocking at our door (see New Members list)—that is news. In forwarding their names to the Secretary, President Whitmore gave the following background for their applications:

These applicants are all from a recently organized map-drafting and cartographic training group, all recent college graduates, and all young women. I enthusiastically endorse each applicant individually, as does Mr. C. A. Newton, their principal instructor. In his orientation comments Mr. Newton suggested that it would be well for them, since they are beginning in a strange profession, to affiliate with some sort of organization. He mentioned the American Society of Civil Engineers, the American Society of Military Engineers, the American Society of Photogrammetry, the American Congress on Surveying and Mapping, and certain local organizations. These particular applicants acted on the suggestion at once, and chose the Congress, largely because the publication, "SURVEYING AND MAPPING" appealed to them.

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